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**MEMORY FOR COMMON AND BIZARRE IMAGERY:  
A STORAGE-RETRIEVAL ANALYSIS**

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**A Thesis  
Presented to the  
Faculty of  
California State University,  
San Bernardino**

---

**In Partial Fulfillment  
of the Requirements for the Degree  
Master of Arts  
in  
Psychology**

---

**by  
Mary Louise LaMay**

**June 1996**

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A STORAGE-RETRIEVAL ANALYSIS

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Mary Louise LaMay


June 1996

Approved by:

  
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5-31-96  
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Robert Cramer

  
Sanders McDougall

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## ABSTRACT

The present study examined storage and retrieval factors in memory for common imagery, in order to determine whether common items benefit storage processes in memory. The variables needed to achieve a commonness effect were identified, which include an unmixed-list design, cued recall, intentional learning, a short presentation rate, and immediate recall. Subjects were presented with 20 noun pairs which were embedded in either common or bizarre sentences. An empirical analysis indicated that a significant commonness effect was achieved. To determine whether this significant commonness effect was due to storage or retrieval factors, Riefer and Rouder's (1992) multinomial model for measuring storage and retrieval was utilized. The model revealed that common items do indeed benefit storage processes in memory. Results are discussed in terms of previous findings and various theories of the bizarreness effect.

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## INTRODUCTION

Bizarre imagery is a mnemonic device that is often used to enhance memory. Several studies have obtained the bizarreness effect, which is the finding that bizarre images are recalled more frequently than common images (e.g., Iaccino, Dvorak, & Coler, 1989; McDaniel, Einstein, DeLosh, May, & Brady, 1995). Although bizarre imagery is often thought to be a useful memory aid, in which the subjects themselves often predict that they will recall bizarre images better (Kroll, Jaeger, & Dornfest, 1992), it has also been found that common images can be recalled just as well as, and sometimes better than, bizarre images (Kline & Groninger, 1991; Wollen & Cox, 1981a). This phenomenon is known as the commonness effect.

The present experiment examined various theoretical concepts behind the bizarreness and commonness effect. However, it was their relationship to storage and retrieval processes in memory that was of particular interest. Once information is initially encoded, or learned, then the information is stored during the interval between encoding and the time of recall. However, in order to recall the information, it must also be retrieved (Smith, 1980). Riefer and Rouder (1992) examined the relationship between storage and retrieval processes in bizarre imagery, utilizing a multinomial modeling analysis, and they established that bizarre images are retrieved better than common images.

Although it has been determined that the bizarreness effect benefits

retrieval (Riefer & Rouder, 1992), there is no literature that has specifically investigated the commonness effect, in order to determine whether common sentences benefit the storage of items or their retrieval. In other words, it is uncertain whether common images are stored or retrieved better than bizarre images. When a commonness effect has been found in prior research, it has usually been the unintended result of an initial attempt to obtain a bizarreness effect. Therefore, unlike past research, the present experiment was designed to obtain a commonness effect alone. Once the commonness effect was reached, Riefer and Rouder's (1992) multinomial modeling analysis was applied to determine whether the commonness effect benefits from storage processes in memory.

### Early Attempts to Obtain the Bizarreness Effect

Most early studies on bizarre versus common imagery focused on the bizarreness effect. It was initially thought that the more bizarre an item is, the easier it is to remember (Lorayne & Lucas, 1974). This idea was not always supported by the early literature, because initial research often failed to find a bizarreness effect (Hauck, Walsh, & Kroll, 1976; Senter & Hoffman, 1976; Webber & Marshall, 1978). For example, Wollen, Webber, and Lowry (1972) attempted to obtain a bizarreness effect, and examined the effects of interaction on bizarreness using pictorial stimuli. Two items in a picture are said to interact

when they are somehow joined; for instance, a bizarre interaction between the noun 'piano' and 'cigar' may show a piano smoking a cigar. After presenting drawings to subject in four different conditions (non-interacting, non-bizarre; non-interacting, bizarre; interacting, non-bizarre, interacting, bizarre), Wollen et al. found that bizarreness had no effect on recall performance. Memory for bizarre images was only facilitated to the extent that the image also depicts interaction. Therefore, they concluded that interaction was the only effective variable, and there was no significant difference in the recall of common and bizarre imagery.

In another early study that failed to show a bizarreness effect, Nappe and Wollen (1973) attempted to obtain a bizarreness effect by first having subjects form either common or bizarre images, which they later scored for degree of bizarreness. They found no difference in common versus bizarre images; however, bizarre images took longer than common images for the subjects to form. It was found that experience had no effect on forming bizarre images, other than increasing the speed of imagery formation. Nappe and Wollen concluded that this failure to obtain a bizarreness effect may have been due to the subjects' lack of experience in using mental imagery.

In an early experiment that did find the bizarreness effect, Andreoff and Yarmey (1976) noted that, in most research, bizarre imagery has little influence on immediate recall of paired associates; therefore, they tested the effects of bizarreness on delayed recall. They found that bizarreness does affect recall,

but only in a delayed (24 hour) condition. This was explained in terms of a cognitive elaboration hypothesis, in which bizarre imagery leads to novel cognitive elaborations which are more distinguishable than common elaborations. The bizarre elaborations, due to their novelty, may lead to less inter-pair interference, and therefore, a greater resistance to forgetting.

Although Andreoff and Yarmey (1976) found a bizarreness effect, most early research on bizarre imagery failed to find a bizarreness effect, and sometimes instead found that common items are remembered better (Collyer, Jonides, & Bevan, 1972; Emmerich & Acherman, 1979). It became increasingly apparent that common items can be just as effective in memory as bizarre items.

#### Recent Attempts to Obtain the Bizarreness Effect

Following early failures to obtain a bizarreness effect, more recent research has established that there are several specific variables that can be manipulated in order to achieve this effect (Einstein & McDaniel, 1987). List-type became an important variable after initial research, which focused on unmixed-list designs, consistently failed to reach a bizarreness effect. An unmixed-list, in which one group of subjects receives a list of only bizarre sentences, and another group of subjects receives only common sentences, fails to produce a bizarreness effect (Collyer et al., 1972). The literature instead shows that a mixed-list design, in which subjects are presented with both bizarre

and common sentences, facilitates the bizarreness effect (McDaniel & Einstein, 1986; PraBaldi, DeBeni, Cornoldi, & Cavedon, 1985). The subject may not identify a sentence as bizarre unless he or she also sees the other sentences in a common format. Therefore, the bizarreness effect is enhanced only in the context of common sentences. Cox and Wollen (1981) attempted to contradict past research, and examined whether they could achieve a bizarreness effect when using an unmixed-list design. They found no significant difference between bizarre and common conditions. The bizarre conditions produced lower recall of complete sentences; thus they concluded that bizarreness is only found in mixed-list designs.

Cued recall versus free recall is another determinant of the bizarreness and commonness effect. In a free recall paradigm, subjects are asked to recall both items in a noun-pair without a cue, versus a cued recall paradigm in which the first noun in a noun-pair is given. Early research only examined cued recall, and did not get the bizarreness effect (Hauck et al., 1976). However, more recent research has consistently found that, especially when paired with a mixed-list design, the bizarreness effect is obtained with free recall, but not with cued recall (McDaniel & Einstein, 1986; Merry, 1980). Wollen and Cox (1981b) examined the bizarreness effect in a multi-trial learning task, and tested subjects in either free or cued recall conditions. They found that in free recall, bizarre materials produced significantly greater recall than common materials, and in cued recall, common materials produced consistently greater recall.

Wollen and Cox (1981a) also examined whether bizarreness is effective only with free recall, and discovered a potential cueing effect in bizarre sentences that is not present in common sentences. For example, the two common sentences, 'The hen pecked the worm,' and 'The man smoked the cigar,' can be changed to bizarre sentences such as 'The man pecked the worm,' and 'The hen smoked the cigar.' In a free recall paradigm, if a subject first recalls the sentence, 'The hen smoked the cigar,' this may cue the second sentence, because the word 'hen' may cue the word 'worm,' which is part of the common sentence. Wollen and Cox (1981a) speculated that this subject-supplied intersentence cueing may be the cause of the bizarreness effect, rather than the mixed-list, free recall paradigm.

As indicated earlier, another variable that can be manipulated in order to obtain the bizarreness effect is delay of recall. Andreoff and Yarmey (1976) tested subjects with either immediate recall or recall after a 24-hour delay. There was no difference between common and bizarre imagery in immediate recall, but there was an advantage for bizarre imagery with delayed recall. O'Brien and Wolford (1982) also examined the effects of delay on recall of noun pairs in both common and bizarre paradigms. They found that after a one-week delay, the bizarreness effect was facilitated. However, after a three-day delay, there was no difference in commonness and bizarreness.

Early research that failed to obtain a bizarreness effect used intentional learning tasks, in which the researchers told the subjects that there would be a

memory test. However, recent research has utilized incidental learning tasks, which aid the bizarreness effect. In an incidental learning task, subjects are not told that the experiment involves a memory test. Instead, subjects are told that the task of the experiment is to observe sentences, and then to rate them, on a scale of one to five, for either imagery (Cox & Wollen, 1981), bizarreness (McDaniel & Einstein, 1989), or vividness (Iaccino et al., 1989). This is followed by a surprise memory test. An intentional learning task often decreases the bizarreness effect (Collyer et al., 1972; Emmerich & Ackerman, 1979). However, this is not always the case; some research has obtained a commonness effect when using incidental learning rather than intentional learning (PraBaldi et al., 1985; Wollen & Cox, 1981a).

As mentioned earlier, when researchers use incidental learning to obtain a bizarreness effect, they typically have subjects rate stimuli on vividness, bizarreness, or interactiveness. Research shows that having subjects rate the vividness of their imagery produces the strongest bizarreness effect. McDaniel and Einstein (1986) found that rating images for vividness showed a bizarreness effect with an intervening list of common images, but not with an intervening list of bizarre images, or an intervening list of semantically related words. In a similar study, Kroll, Schepeler, and Angin (1986) failed to find a significant bizarreness effect, but they too showed an increase in bizarre imagery following a vividness rating task. Subjects were asked to first image, and then rate sentences for bizarreness, vividness, and/or interaction. Subjects recalled more

bizarre sentences following the vividness rating task, but not the bizarreness or interaction rating tasks. Kroll et al. (1986) suggested that rating sentences in three separate tasks may inadvertently lead subjects into semantic processing, rather than imagery processing. Also, there may have been a difference in encoding strategies between high and low-imagers, with high-ability imagers encoding pictorial stimuli literally, which leads to more accurate encoding (O'Brien & Wolford, 1982).

The occasional failure to obtain a bizarreness effect even when using free recall and a within-subjects design may be due to sentence complexity (McDaniel & Einstein, 1989). McDaniel and Einstein stated that increased sentence complexity decreases the level of imageability, and when rating images, complex sentences produce a significantly lower image rating than do short, plausible sentences. Complex sentences may cause subjects to produce more elaboration of the target nouns, but their memory is not enhanced unless the elaboration makes the relationship between the target nouns less arbitrary. McDaniel and Einstein found that memory for bizarre imagery is facilitated when sentences are simple, and that the advantage of bizarre imagery is eliminated when sentences are complex.

A recent experiment on bizarre imagery also examined sentence complexity. Robinson-Riegler and McDaniel (1994) examined why the mnemonic benefit of bizarreness is not found when additional modifiers of nouns are added into the stimuli. The bizarreness of the complex sentences was not



utilized by subjects during retrieval, and the cues for complex sentences were more precise than the cues associated with bizarre sentences. It was determined that simple, unelaborated sentences aided the bizarreness effect, and complex sentences containing additional modifiers of nouns did not. Therefore, the bizarreness effect is weaker when sentences are complex.

Bizarreness and commonness are not only affected by sentence complexity, but also by presentation time. Due to the novelty of bizarre sentences, they take a relatively longer amount of time to process than common sentences. Kline and Groninger (1991) examined presentation rates and their effect on bizarre imagery, and found that a short presentation rate (11 seconds) facilitated common sentences, and a longer presentation rate (15 seconds) facilitated bizarre sentences.

### Theoretical Accounts of the Bizarreness Effect

It is apparent that the bizarreness effect is a well established phenomenon, with specific variables that have been identified to obtain this effect. Based on this research, it is clear that we know how to find a bizarreness effect. However, thus far, only methodological considerations of the bizarreness effect have been discussed; there are also theoretical considerations.

The following theories, proposed by Einstein and McDaniel (1987) provide possible explanations for cognitive processes important to the

bizarreness effect. Their attentional hypothesis states that bizarre sentences arouse attention and interest due to their novelty (Merry, 1980), and therefore receive a greater amount of processing than common sentences, which improves memory. This potentially explains why the bizarreness effect occurs in mixed-lists and not unmixed-lists. In a mixed-list, subjects may focus their attention on the bizarre sentences; however, in an unmixed-list, subjects devote their full attention to whatever sentence they are presented with, whether it be bizarre or common (Wollen & Cox, 1981a). Therefore, the context of common images is necessary in order to focus attention on bizarre images.

Einstein and McDaniel (1987) also discuss the distinctiveness hypothesis, which states that the distinctiveness of an event is determined by its relation to other encoded events. They state that bizarre images usually depict more exaggerated, distorted, or unusual relationships among objects, and are, by definition, more distinctive than common images. The distinctiveness of an event can be determined by two factors. First, the distinctive items shares few features in common with other information in memory, which is true of bizarre items. The second factor asserts that distinctiveness is defined in a relative manner, in which the uniqueness of the event is determined by its relationship relative to other items in the list. Therefore, bizarre materials should produce encodings that are relatively more distinctive in the context of common materials than in the context of bizarre materials. This explains why the bizarreness effect occurs in mixed-list designs, and not in unmixed-list designs (McDaniel &

Einstein, 1991).

The retrieval inhibition hypothesis (Einstein & McDaniel, 1987) states that the retrieval of one item in a list may inhibit the retrieval of other items in the same list. In other words, strong items block the access to weak items. This hypothesis states that bizarre images have a better representation in memory than common images, and because of this, bizarre images block the retrieval of common images. This is especially true in mixed-list designs.

Riefer and Rouder (1992) reviewed these theories and framed them in terms of storage and retrieval processes. For instance, the attentional hypothesis is a storage-based explanation of the commonness effect, and the retrieval inhibition hypothesis uses retrieval factors to explain the bizarreness effect. According to Riefer and Rouder, evidence for the retrieval explanation of the bizarreness effect occurs because memory for bizarre imagery is enhanced by free recall and not cued recall. This occurs because cued recall tends to lessen the importance of retrieval processes.

#### Riefer and Rouder's Multinomial Model

In order to examine storage and retrieval processes in bizarre imagery, Riefer and Rouder (1992) developed a mathematical model, known as a multinomial model, to measure unobservable cognitive events. To measure these processes, subjects engage in a standard paired-associate paradigm in

which two capitalized nouns (the stimulus and response) are embedded within a common or a bizarre sentence. The subject is told to form an image between the two nouns in each sentence, in order to recall them in a memory test which follows presentation of the sentences. The subjects are then tested in both a free recall, followed by a cued recall memory test. For instance, subjects may be given the bizarre sentence, 'The MAN was wearing the CHAIR.' In the cued recall condition, the subject is given the word 'MAN,' and is asked to recall the word 'CHAIR,' and in a free recall paradigm, the subject is asked to recall both 'MAN' and 'CHAIR,' without any cues.

From this standard testing procedure, free-recall responses fall into three categories: subjects freely recall both words, they recall the stimulus or response term (but not both), or they recall neither term. In cued recall, subjects either recall the response or they do not recall it. From this information a statistical model can be developed, based on five statistical parameters, which can determine whether recall of the bizarre items is due to retrieval and whether recall of the common items is due to storage.

The multinomial modeling analysis evolves statistically from the analysis of six separate recall events:

$E_1$  - both items freely recalled, correct cued-recall;

$E_2$  - one and only one item freely recalled, correct cued-recall;

$E_3$  - neither item freely recalled, correct cued-recall;

$E_4$  - both items freely recalled, incorrect cued-recall;

$E_5$  - one and only one item freely recalled, incorrect cued recall;

$E_6$  - neither item freely recalled, incorrect cued-recall.

The probability of these six recall events can be obtained through a statistical analysis which begins with the following hypothetical cognitive events, represented by parameters  $a$ ,  $r_1$ ,  $r_2$ ,  $s_1$ ,  $s_2$  in the model. These cognitive events are:

$a$  - probability of forming and storing a stimulus-response association;

$r_1$  - retrieval of the association during free-recall;

$r_2$  - retrieval of the association during cued-recall;

$s_1$  - probability that exactly one item in a pair is recalled independently during free-recall;

$s_2$  - probability of singleton recall of non-retrieved associates.

Of these five items, the two that are most important to the present experiment are  $a$ , which measures storage, and  $r_1$ , which measures retrieval. The remaining parameters,  $r_2$ ,  $s_1$ , and  $s_2$ , are less important to the storage and retrieval issues, and are considered nuisance variables.

From these five parameters, the probabilities for each data event can be established using the following formulas:

$$P(E_1) = ar_1r_2,$$

$$P(E_2) = a(1-r_1)r_2s_1,$$

$$P(E_3) = a(1-r_1)r_2(1-s_1),$$

$$P(E_4) = ar_1(1-r_2),$$

$$P(E_5) = a(1-r_1)(1-r_2)s_1 + (1-a)s_2,$$

$$P(E_6) = a(1-r_1)(1-r_2)(1-s_1) + (1-a)(1-s_2).$$

Once the probabilities are established, the closed-form solutions for the parameters are then determined:

$$a = [(N_1 + N_2 + N_3)(N_1 + N_4)] / NN_1,$$

$$r_1 = N_1 / (N_1 + N_2 + N_3),$$

$$r_2 = N_1 / (N_1 + N_4),$$

$$s_1 = N_2 / (N_2 + N_3),$$

$$s_2 = (N_1N_5 - N_2N_4) / [N_1(N_5 + N_6) - N_4(N_2 + N_3)].$$

In these closed form solutions,  $N_i$  is the frequency of the  $E_i$  events, and

$$N_i = N_1 + N_2 + N_3 + N_4 + N_5 + N_6.$$

In observing the model, it can be seen there are five parameters as well as five independent data events. This leaves no degrees of freedom in which to test the goodness of fit to the model. In order to free up one degree of freedom, it is possible to set parameters  $s_1$  and  $s_2$  (the singleton parameters) equal to each other (i.e.,  $s_1 = s_2$ ). This is an acceptable solution in many situations because both of these parameters represent recalling individual items that were not recalled as word pairs. The unrestricted version of the model, in which  $s_1$  and  $s_2$  represent two separate events, is known as case I; the restricted version of the model, in which  $s_1 = s_2$ , is known as case II.

Riefer and Rouder (1992) used their multinomial model to determine the

cognitive processes that facilitate the bizarreness effect. Subjects were presented with both bizarre and common sentences utilizing a mixed list design, and an incidental learning task. Riefer and Rouder had subjects rate the sentences for vividness, and presented subjects with a free recall, followed by a cued recall memory test. The bizarreness effect was found in two of three variations of this experiment. The multinomial modeling analysis was then used to determine whether this effect was due to storage or retrieval. It was found that in the two experiments, subjects retrieved significantly more bizarre than common noun-pairs. Therefore, bizarre sentences benefited from retrieval, and not from storage processes in memory.

### The Current Study

In their research on bizarre imagery, Riefer and Rouder (1992) applied their multinomial modeling technique and found, as they hypothesized, that the bizarreness effect is indeed due to higher rates of retrieval in memory. They focused on storage and retrieval processes in bizarre imagery; however, the commonness effect was not of primary interest in their study. Therefore, they found that neither bizarre sentences, nor common sentences benefited from storage within memory. This thesis examined the role of different cognitive processes in memory, but more specifically, it determined the relationship between common items and storage processes in memory. It is reasonable to

theorize that common items benefit storage because, unlike bizarre items which are often difficult to relate to, common items are easy to relate to, making them easier to store into memory.

Of course, in any study, to determine if common images are stored better in memory, one must first obtain a commonness effect. Past research focused almost exclusively on obtaining the bizarreness effect. As mentioned earlier, many of the studies often found the commonness effect instead, even though this was not the initial purpose of those studies. Rather than attempt to obtain a bizarreness effect, the present study was designed to obtain a commonness effect in order to determine if the effect was due to storage or retrieval. This attempt to obtain a commonness effect was unique to the present experiment, and has not been done in past research.

To obtain the commonness effect, none of the methods previously discussed to obtain the bizarreness effect were utilized. Instead, opposite methodologies than those used to obtain a bizarreness effect were used. The methodologies utilized in the present experiment included an unmixed-list design (Collyer et al., 1972; Emmerich & Acherman, 1979), using both free as well as cued recall (PraBaldi et al., 1985; Wollen & Cox, 1981a, 1981b), using intentional learning in which subjects are told that there will be a memory test (Collyer et al., 1972; Emmerich & Ackerman, 1979; Wollen & Cox, 1981b), using a short (10 second) presentation rate (Kline & Groninger, 1991), and using immediate recall (O'Brien & Wolford, 1982). Once the present study reached



the commonness effect, Riefer and Rouder's (1992) multinomial modeling analysis was applied in order to analyze storage processes in memory. Given these methodologies, we expected to obtain a commonness effect, with results indicating that the commonness effect was due to storage.

## METHOD

### Subjects

Subjects consisted of 75 male and female undergraduate students from the University of California at Irvine, each receiving extra course credit for their participation.

### Materials

Subjects were presented with 20 sentences. Each sentence contained a noun-pair (e.g. BANKER-NEWSPAPER) which described either a bizarre relationship or a common relationship between two objects. An example of a common sentence for the noun-pair BANKER-NEWSPAPER was 'The BANKER read the NEWSPAPER;' its corresponding bizarre sentence was 'The BANKER floated on the NEWSPAPER.' The noun-pairs were capitalized within each sentence. Most of the sentences were modifications of those used by McDaniel and Einstein (1986) and Riefer and Rouder (1992), and the full set of sentences

is listed in the Appendix.

## Design

The experimental design utilized in the experiment was a 2 X 2 mixed design. The first independent variable was type of sentence (bizarre vs. common), and was the between-subjects variable. Sentences were either all common or all bizarre, with 38 subjects receiving common sentences and 37 subjects receiving bizarre sentences. The second independent variable was type of recall. Recall was either free or cued, and was the within-subjects variable.

## Procedure

Subjects were run in six groups ranging from 10 to 14 people each. Sentences were presented on slides projected onto a screen in front of subjects at a rate of 10 s per sentence. Sentences were presented one at a time, in random order, to each set of subjects.

Following presentation of the sentences, subjects were given a three min distractor task in which they circled small differences between pairs of nearly identical pictures. Subjects were then given a three min free recall period in which they recalled both the stimulus and response items onto a blank piece of

paper. Subjects were instructed to recall both items of each noun-pair, and if they could not remember both items, they were asked to write down what items they did remember. Immediately following the free recall portion was the cued recall portion, in which the stimulus of each pair was presented in random order on a single sheet of paper. It was the subjects' responsibility to recall the second item in each noun-pair. The cued portion also lasted three minutes.

## RESULTS

### Empirical analysis

All statistical tests were conducted using the .05 level of significance. Table 1 presents the proportion of bizarre and common noun-pairs correctly recalled in both free and cued recall conditions. Free recall was measured in terms of the number of noun-pairs in which at least one item was freely recalled. Cued recall was measured in terms of the number of correct responses to the second noun when the first noun was given as a cue (cf. Riefer & Rouder, 1992).

An analysis of variance revealed that there was a significant difference in subjects' recall of bizarre and common sentences, with subjects recalling more common sentences than bizarre sentences,  $F(1, 73) = 12.46$ . In addition, subjects recalled more items during cued recall than during free recall,  $F(1, 73) = 202.35$ . As Table 1 indicates, there was a slight commonness effect

Table 1

*Proportion of Bizarre and Common Noun-Pairs Recalled*

Sentence	Free Recall	Cued Recall
Bizarre	.46 (.13)	.67 (.23)
Common	.55 (.13)	.82 (.15)

*Note.* Numbers in parentheses are standard deviations.

in the free recall condition, with an even greater advantage for common items in the cued recall condition. However, this interaction between item type and type of recall failed to reach significance,  $F(1, 73) = 2.69$ .

### Model analysis

Riefer and Rouder's (1992) multinomial modeling analysis was applied in order to determine whether the advantages of common imagery were due to storage or retrieval processes in memory. In order to determine this, it was necessary to first calculate the  $N_i$  statistics. These statistics are presented in Table 2, with an  $N$  of 740 for the bizarre condition, and 760 for the common condition.

Riefer and Batchelder (1988) describe how the loglikelihood ratio statistic  $G^2$  can be used to evaluate the fit of the multinomial models. According to Riefer and Rouder (1992), the model can be analyzed through either case I or case II of the model. Case I utilizes all five parameters ( $a, r_1, r_2, s_1, s_2$ ), while case II assumes that  $s_1 = s_2$ , and thus utilizes only four parameters ( $a, r_1, r_2, s$ ). This frees up one degree of freedom for testing the model. The  $G^2$  statistic is asymptotically distributed as a chi-square variable, and a critical value of 5.99 was utilized based on two degrees of freedom. To test the goodness of fit in the present experiment, case II of the model was applied to the data set, which resulted in a significantly poor fit,  $G^2(2) = 20.26$ . Therefore, case I of the model

Table 2

*Data Statistics for Bizarre and Common Imagery*

Sentence	$N_1$	$N_2$	$N_2$	$N_4$	$N_5$	$N_6$
Bizarre	294	13	186	3	36	208
Common	391	4	223	2	14	126

*Note.*  $N_1$  = both items freely recalled, correct cued recall;  $N_2$  = one and only one item freely recalled, correct cued recall;  $N_3$  = neither item freely recalled, correct cued recall;  $N_4$  = both items freely recalled, incorrect cued recall;  $N_5$  = one and only one item freely recalled, incorrect cued recall; and  $N_6$  = neither item freely recalled, incorrect cued recall.

was utilized for all subsequent data analyses.

The parameter estimates from case I of the model are presented in Table 3. The values of  $r_2$  are relatively high, which indicates that the storage of a noun-pair generally resulted in correct cued recall for that pair. However, the free-recall retrieval differences, which are indicated by  $r_1$ , are more pertinent to the present experiment. Common and bizarre sentences did not significantly differ on their retrievability, as measured by parameter  $r_1$ ,  $G^2(1) = 1.53$ . The storage parameter, represented by  $a$ , is also highly pertinent to the present experiment. Table 3 indicates that the storage difference showed an advantage for common items over bizarre items (.82 versus .67 respectively), and this effect reached statistical significance,  $G^2(1) = 40.47$ . The only other significant finding was that parameter  $s_1$  showed a significant bizarreness effect,  $G^2(1) = 6.53$ . Parameter  $s_1$  was a nuisance variable, and its results were not pertinent to the present experiment. However,  $s_1$  incorporates both storage and retrieval processes, which indicates that this may be due to a type I error. The  $s_2$  statistic also showed a slight, but nonsignificant, bizarreness effect,  $G^2(1) = 1.81$ .

## DISCUSSION

The bizarreness and commonness effects can now be explained in terms of a two-factor explanation involving storage and retrieval. Riefer and Rouder (1992) established that bizarre images benefit from retrieval processes in

Table 3

*Parameter Estimates For the Multinomial Model*

Sentence	$a$	$r_1$	$r_2$	$s_1$	$s_2$
Bizarre	.67	.60	.99	.07	.15
Common	.82	.63	.99	.02	.10

*Note.*  $a$  = probability of storing the association;  $r_1$  = probability of retrieving the association in free recall;  $r_2$  = probability of retrieving the association in cued recall;  $s_1$  = probability of recalling a non-retrieved associate as a singleton;  $s_2$  = probability of recalling a non-associated item as a singleton.



memory. Results of the present experiment indicate that common images benefit from superior storage processes in memory. Before examining the storage and retrieval aspects of the study, the variables necessary to obtain a commonness effect first had to be identified. This seemingly straightforward task was actually quite complicated since past research had not specifically examined the commonness effect. McDaniel and Einstein (1991) previously identified a mixed-list design, and free recall as variables needed to reach a bizarreness effect. The present study also identified incidental learning, delayed recall, and a long presentation rate. It was theorized that by reversing them, a commonness effect should be obtained. Therefore, the variables that were manipulated in order to reach a commonness effect were an unmixed-list design, cued recall, intentional learning, immediate recall, and a short presentation rate. After a significant commonness effect was reached, it was then possible to utilize Riefer and Rouder's (1992) multinomial modeling analysis in order to determine whether common items benefit storage or retrieval processes in memory.

The results of the empirical analyses were as hypothesized, with subjects recalling significantly more common sentences than bizarre sentences. The significant advantage of cued recall over free recall was an expected finding, and is consistent with previous research (Wollen & Cox, 1981b). Riefer and Rouder (1992) produced a significant bizarreness effect for free recall, but failed to show an advantage for bizarre imagery in cued recall. The present results are

an extension of those findings, and verify that there is an advantage for common imagery in cued recall (Emmerich & Acherman, 1979; O'Brien & Wolford, 1982; Wollen & Cox, 1981a).

It was only after a significant commonness effect was reached that we could examine the storage and retrieval parameters by utilizing Riefer and Rouder's (1992) multinomial model. The  $N_i$  statistics indicate that there was a commonness effect for  $N_1$  (294 for bizarre and 391 for common), the statistic that measures when both items are freely recalled, with correct cued recall. In addition, the parameter estimates show that there was a significant advantage for common items in storage parameter  $a$ . Thus, Riefer and Rouder's (1992) multinomial model provided a good fit to the data and supported the hypothesis that common items benefit storage.

The two-factor theory helps to explain why the bizarreness effect is weak or nonexistent in prior research. Since common items are stored better, they may tend to neutralize the retrieval advantage of bizarre imagery, and thus weaken or eliminate the bizarreness effect in many experiments. The two-factor theory also explains why the bizarreness effect is not usually found in cued recall. In a cued recall paradigm, the first word of a word pair is given, and it is the subjects' responsibility to identify the second word. Presenting subjects with a cue minimizes retrieval, and thus neutralizes the bizarreness effect.

The two-factor theory can explain why the commonness effect is stronger with intentional learning. In an intentional learning paradigm subjects are told

that there will be a memory test, unlike an incidental learning paradigm in which subjects are not told of an impending memory test. When subjects are told that there will be a memory test, they may make an attempt to remember items by utilizing various memorization techniques, thus storing the items better. This should benefit memory for common imagery.

Immediate recall benefits the commonness effect because storage of information should be best immediately after list presentation. However, delayed recall should benefit the bizarreness effect because presumably after a long delay, the bizarre items should come more readily to mind than the common items, and thus be retrieved better. This supports findings by O'Brien and Wolford (1982) who examined delay of recall and the bizarreness effect. They found that the bizarreness effect is facilitated after a one-week delay, and there was no difference between commonness and bizarreness after a three-day delay. The present experiment extends those findings by identifying an advantage for common items with an immediate recall test. An area of future research could be to examine delay of recall with a recall of less than three days.

The two-factor explanation is consistent with current theory on storage and retrieval processes. For example, the fact that bizarre imagery is retrieved better is consistent with the distinctiveness hypothesis (Einstein & McDaniel, 1987), which states that bizarre images are more distinctive than common images due to their unusual or exaggerated relationships among objects.

McDaniel et al. (1995) state how the distinctiveness hypothesis can be explained in terms of retrieval processes in memory. The bizarre items are more distinctive and tend to stand out more, making them easier to retrieve. In addition, Nappe and Wollen (1973) found that bizarre images take longer to form than common images, and the extra processing that is required for bizarre imagery provides an explanation for a storage disadvantage in bizarre imagery.

Common items are more easily stored because they are easy to relate to, they are more easily integrated, and they require less distinctive elaborations (Andreoff & Yarmey, 1976; Wollen & Cox, 1981b). Unlike bizarre sentences, which are unusual by nature, the common sentences are not unusual, and are easy to relate to, thus making them less distinctive. Distinctiveness is determined both in relation to the context in which an item is presented, as well as to a subject's prior knowledge of the item (McDaniel et al., 1995). Since common items are consistent with a subjects existing schema, this indicates that a storage advantage may occur because subjects rely on their existing schema or prior knowledge of the common items (Bransford & Franks, 1971, 1972; Bransford & Johnson, 1973). This makes storage of common sentences easier than bizarre sentences.

The question can be raised whether item differences possibly account for the results of this experiment. The present study utilized a between-subject design, and therefore different subjects saw different sentences. It is possible that the common items may have been recalled better, not because of the

commonness effect, but because the common sentences were easier due to item differences between each set of sentences. This possibility is not likely, however, because the sentences utilized in the present experiment were based on the same sentences previous researchers have used to successfully obtain a bizarreness effect (McDaniel & Einstein, 1986; Riefer & Rouder, 1992). It should be pointed out that six new sentences were constructed specifically for the present experiment. To determine whether these new sentences created any item differences, an analysis was conducted comparing the proportion correct of the 20 sentences used in the experiment with the proportion correct of the 14 sentences, which excluded the six created by the experimenter. This new proportion correct was essentially unchanged in all experimental conditions. Therefore, use of the six sentences did not alter the results, and does not account for the recall advantage of the common sentences.

The present experiment has provided a plausible explanation for the bizarreness and commonness effect. The inconsistencies of past research on the bizarreness effect can be explained with a simple two-factor theory that identifies a storage advantage for common imagery and a retrieval advantage for bizarre imagery. Although the present study has determined that common items benefit storage, the commonness effect itself has not been studied extensively. The present experiment, by determining the storage and retrieval parameters to explain the effect, has provided future researchers with a model to further examine common imagery.

## APPENDIX

### Common and Bizarre Sentences

The HORSE ate the HAY.  
THE HORSE smoked the HAY.

The BOY fed the CAT.  
The BOY juggled the CAT.

The GIRL kissed the DOLL.  
The GIRL boiled the DOLL.

The CAR drove past the FENCE.  
The CAR was petting the FENCE.

The GOLDFISH was swimming in the BOWL.  
The GOLDFISH was eating out of the BOWL.

The LAMP shined on the BOOK.  
The LAMP read the BOOK.

The WOLF howled at the MOON.  
The WOLF lassoed the MOON.

The MAID spilled the AMMONIA.  
The MAID drank the AMMONIA.

The SUN set in the WEST.  
The SUN did back flips in the WEST.

The DOG chased the BICYCLE.  
The DOG rode the BICYCLE.

The SNOWFLAKE fell on the MOUNTAIN.  
The SNOWFLAKE climbed the MOUNTAIN.

The DOCTOR read the JOURNAL.  
The DOCTOR burned the JOURNAL.

The SHOES were placed by the MILK.  
The SHOES were filled with MILK.

The COCKROACH appeared on the STOVE.  
The COCKROACH moved the STOVE.

The BANKER folded the NEWSPAPER.  
The BANKER floated on the NEWSPAPER.

The SPIDER crawled on the SIDEWALK.  
The SPIDER watered the SIDEWALK.

The NURSE worked at the COMPUTER.  
The NURSE danced on the COMPUTER.

The SOLDIER was sitting in the CHAIR.  
The SOLDIER was wearing the CHAIR.

The PERFORMER sang for the AUDIENCE.  
The PERFORMER ate the AUDIENCE.

The PLANT rested on top of the TELEVISION.  
The PLANT screamed at the TELEVISION.

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